

SPECIAL SENSES: VISUAL SYSTEM (3)

EXTRAOCULAR MUSCLES:*

SUPERIOR RECTUS (ELEV.)_{D/A}
INFERIOR RECTUS (DEPR.)_{D/B}
LATERAL RECTUS (ABD.)_C
MEDIAL RECTUS (ADD.)_D
SUPERIOR OBLIQUE (ROT. R.)_E
INFERIOR OBLIQUE (ROT. L.)_F

INTRINSIC MUSCLES: *

ILIARY⁶

SPHINCTER PUPILLAE_H

DILATOR PUPILLAE I

The intrinsic muscles are located in the ciliary body (ciliary muscle) and the iris (pupillary dilator and sphincter). Contraction of the *ciliary muscles* (1) wrinkles the ciliary body tissue and puts slack in the processes, giving laxity to the suspensory ligaments (2) and permitting the lens to round up on its own accord (tension in lens fibers) (3). These muscles function (by parasympathetic innervation) during near vision in which greater refractivity is desired. The *dilator pupillae* consists of myoepithelial cells that pull the iris toward the ciliary body, dilating the pupil (sympathetic innervation). The *sphincter pupillae* circumscribes the inner iris; its contraction constricts the iris, narrowing the pupil (parasympathetic innervation). See the uppermost drawing.

VISUAL PATHWAYS: *

VISUAL FIELD_J / VISUAL FIELD_K

LIGHT WAVE $\star (J', K')$

RETINA $\neq (J^2, K^2)$

OPTIC NERVE $\times (J^3, K^3)$ CHIASMA $\times (J^4, K^4)$ TRACT $\times (J^5, K^5)$

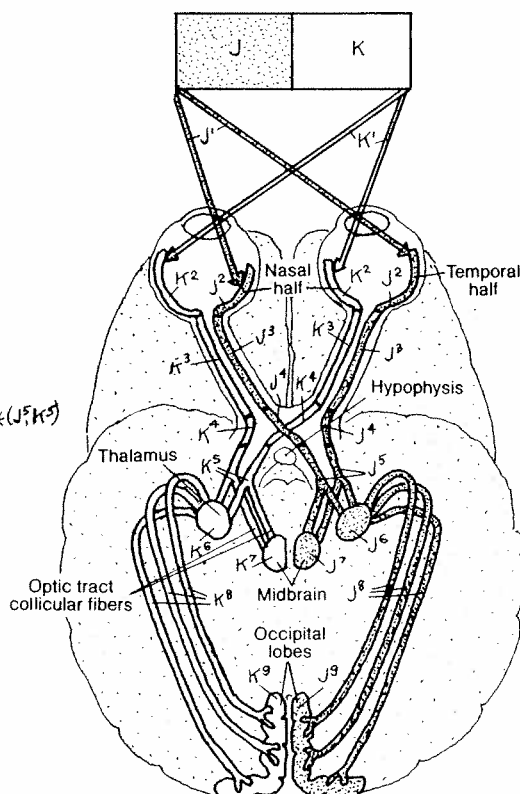
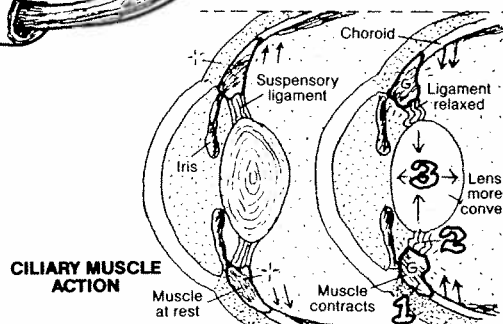
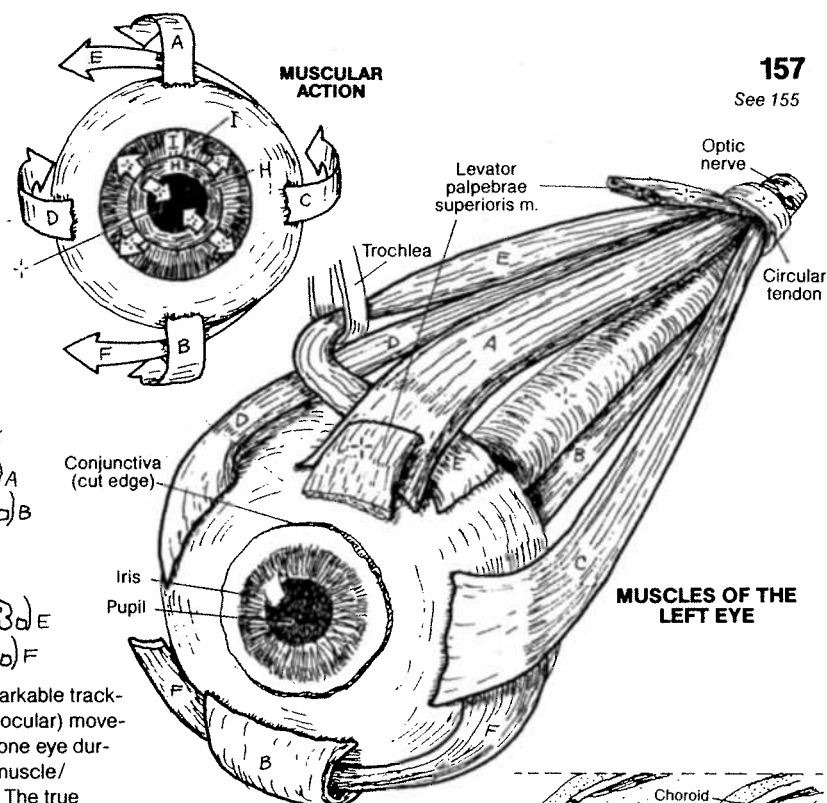
ATERAL GENICULATE BODY * (J.K.)

SUPERIOR COLLICULUS*(J7K7)

OPTIC RADIATION* (J⁸, K⁸)

VISUAL CORTEX * (J⁹, K⁹)

As you color the lower diagram, note that the axons (K^2) from the *retinas* on the temporal side of the optic axis do not cross at the *chiasma*. Note further that an expanding tumor of the hypophysis is likely to impair visual acuity in the temporal visual fields only ("tunnel vision"). The *thalamus* functions as a visual relay center, informing multiple memory areas and other centers of the stimulus. The *superior colliculi* are visual reflex centers, making possible rapid head and body movements in response to a visual threat. Finally, note that the image of the stimulus impinging on the *visual cortex* (K/J) is the reverse of that which was actually seen (J/K). Integration of visual and memory centers at the visual cortex makes possible perception of the image as actually seen.



VISUAL PATHWAYS

XIV. NERVOUS SYSTEM

SPECIAL SENSES: VISUAL SYSTEM (2)

CN: Use the same colors as were used on the previous plate (with different subscripts) for structures J, K, L, M, N', and O. Use light colors for A, G, H, and I. Note that various structures in the central illustration also appear in the illustration below it.

ACCESSORY STRUCTURES: *

LACRIMAL APPARATUS: *

LACRIMAL GLAND_A TEAR_{A'}
DUCT_B

LACRIMAL PUNCTA_C
CANAL_D

LACRIMAL SAC_E
NASOLACRIMAL DUCT_F

INFERIOR MEATUS OF NASAL CAVITY_G

TARSAL PLATE/GLAND_H CONJUNCTIVA_I

Fluid (tears) interfacing the *conjunctivae* of the eyelid (palpebra) and the cornea facilitate easy movement of the lids over the cornea without inducing irritation. Tears also function as a vehicle for moving epithelial debris and microorganisms from the corneal surface and undersurface of the eyelids into the nasal cavity via the lacrimal apparatus. Thus, there is an anatomic basis for blowing your nose after a good cry. The absence of tears can cause remarkable pain and even blindness. The principal gland for tears is the *lacrimal gland*, located in the anterior, superior and lateral (temporal) aspect of the orbit. Other glands and sources of tears include unicellular (goblet) glands of the conjunctiva and *tarsal glands* of the lids. Episodic blinking (rapid cycle of lid approximation and retraction) maintains a film of tears on the conjunctiva and resists "dry eye." Routine closing of the lids occurs with muscle relaxation; energetic closure requires the orbicularis oculi muscle. Retraction of the eyelids is accomplished by smooth muscle fibers (tarsal muscle of Muller, sympathetic innervation) and the levator palpebrae muscle in the upper lid.

SECRETION/ DRAINAGE OF AQUEOUS HUMOR: *

FLOW OF AQUEOUS HUMOR: J

SCLERA_K/CORNEA_{K'}

CILIARY BODY_L PROCESS_{L'}

POSTERIOR CHAMBER_{J'}

IRIS_M

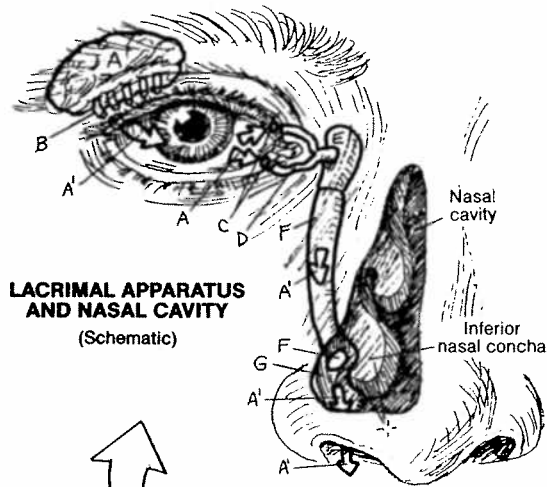
ANTERIOR CHAMBER_{J²}

CANAL OF SCHLEMM_N VEIN_{N'}

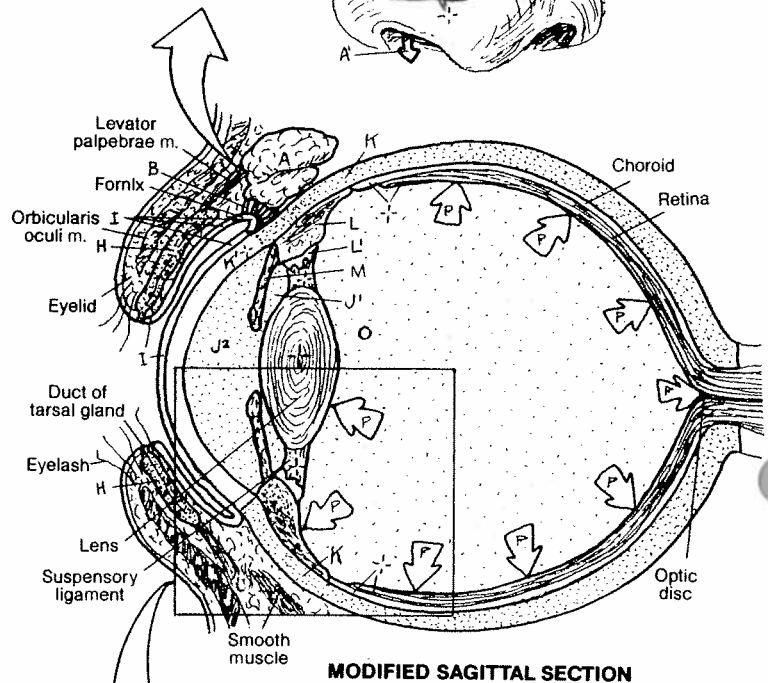
VITREOUS BODY.

INTRAOCULAR PRESSURE (IOP)_P

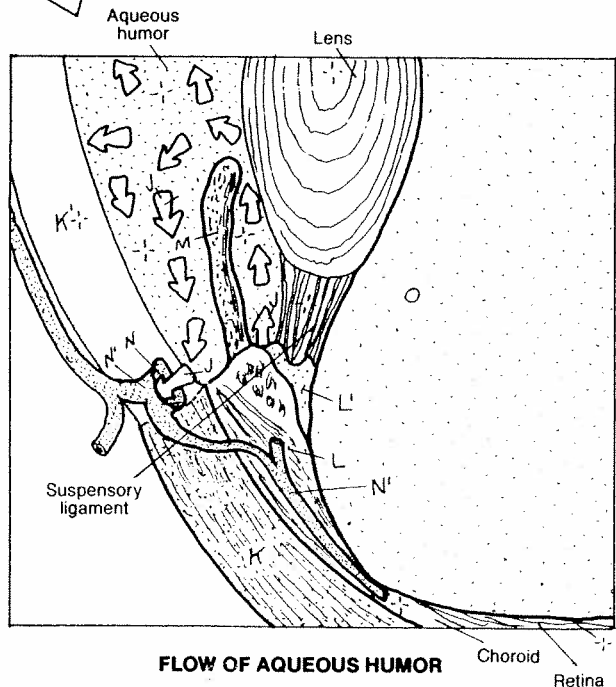
Aqueous humor is a fluid in the anterior and posterior chambers of the eye, secreted by cells of the *ciliary processes*. Fluid and electrolytes also enter by diffusion from the *ciliary body*. Aqueous humor is a clear, plasma-like fluid (but constituted differently). It is filtered into the *canal of Schlemm* (scleral venous sinus), a modified vein filled with fibrous trabeculae, located at the sclero-corneal junction. Fluid in the canal drains into nearby *veins*. Obstruction to drainage is one of several causes of increased *intraocular pressure*, in which the increasing pressure in the anterior/posterior chambers presses on the lens which presses on the *vitreous* (99% water). As water cannot be compressed, pressure is applied to the contiguous retina. Unrelenting pressure compresses vessels to the axons and neurons of the retina, damages neurons, and can result in blindness (glaucoma).



LACRIMAL APPARATUS
AND NASAL CAVITY
(Schematic)



MODIFIED SAGITTAL SECTION



FLOW OF AQUEOUS HUMOR

XIV. NERVOUS SYSTEM

SPECIAL SENSES: VISUAL SYSTEM (1)

DN: Use yellow for M, red for N, blue for O, and very light colors for C, H, I, J, and K. (1) Color the sagittal section of the eyeball and the uppermost illustration simultaneously. (2) When coloring the retinal layers, color gray the arrows (in dark outlines) representing the nerve impulse traveling opposite to the direction of the light rays.

EYE LAYERS:*

SCLERA_A / CORNEA_{A'}

CHOROID_B

CILIARY BODY_C / PROCESS_{C'}

IRIS_D

RETINA_E

OPTIC DISC_F

FOVEA CENTRALIS_G

FLUIDS:*

VITREOUS BODY_H

AQUEOUS HUMOR_I

OTHER STRUCTURES:*

LENS_J

SUSPENSORY LIG._K

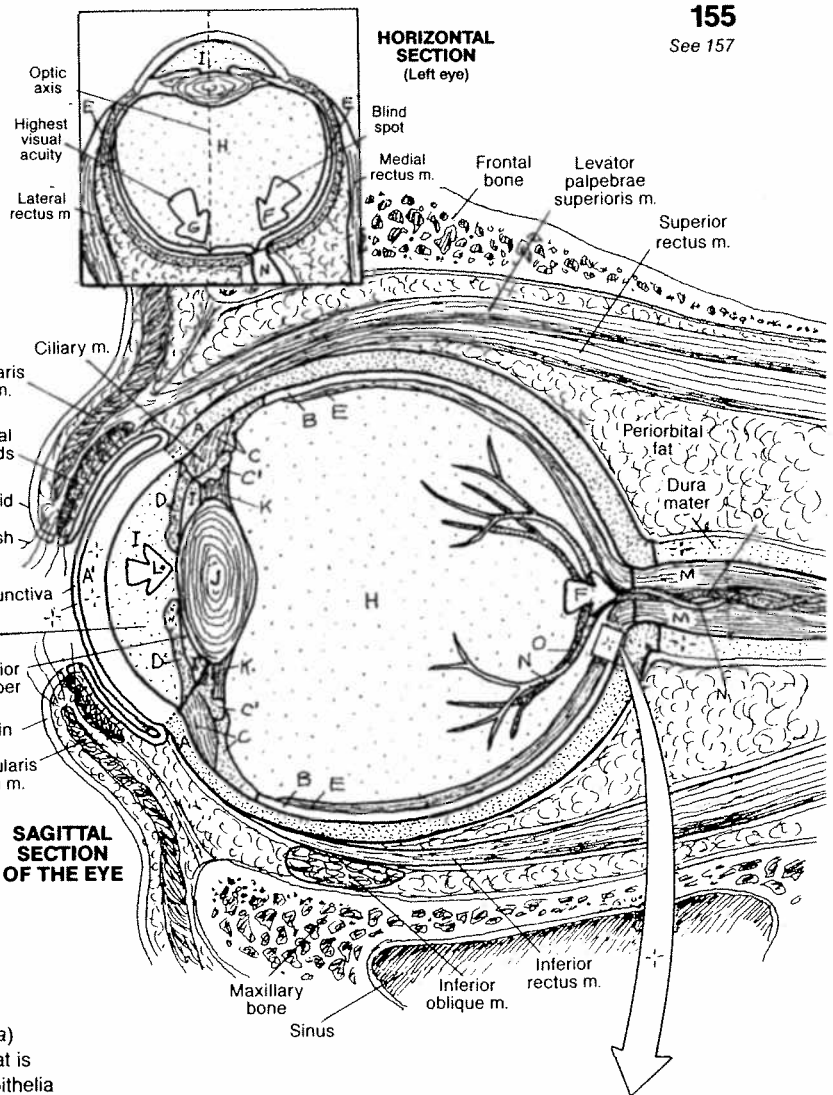
PUPIL_L

OPTIC NERVE_M

RETINAL ARTERY_N / VEIN_O

The eye is a layer of photoreceptor cells and associated neurons (*retina*) packaged within a white, fibrous, rubberlike protective globe (*sclera*) that is transparent in front (*cornea*). The cornea, composed of five layers of epithelia and fibrous tissue, is the chief refractive medium of the eye, focusing light rays onto the retina. The *lens* (tightly packed, encapsulated non-elastic lens fibers derived from epithelial cells) also refracts light, and up to middle age, can vary its shape (and refractive index). The *aqueous humor* (extracellular fluid) filling the anterior and posterior chambers of the eye, and the more gelatinous (99% water) *vitreous humor* taking up 80% of the globe's volume, all function as refractive media. The inner surface of the posterior two-thirds of the sclera is lined with a vascular, highly pigmented layer (*choroid*) that absorbs and prevents scattering of light. The choroid thickens anteriorly as the pigmented, fibromuscular *ciliary body* that surrounds the lens. The ciliary body projects outpocketings (*processes*) to which *suspensory ligaments* from the lens attach. On the anterior aspect of the ciliary body, a thin, pigmented, epithelial and fibromuscular layer (*iris*) circumscribes the hole (*pupil*) in front of the lens.

The retina lines a bit more than the posterior half of the globe, lying superficial to the choroid and against the vitreous. It is a highly vascular membrane, complexly composed of several interlacing layers of cells. At about the center of the retina, a yellow pigmented area (*macula lutea*) with a clearly depressed region characterized by a dense accumulation of light-sensitive cells (*cones*) occurs. This site (*fovea centralis*) represents the center of greatest visual acuity (clarity of form and color) under lighted conditions. About 3mm to the nose-side of the macula lutea, the axons of the *optic tract* (nerve) and *retinal arteries/veins* stream out of the globe (*optic disc*). Absent neurons, it is an area from which no vision is possible (*blind spot*). The retina, derived from an evagination of the diencephalon, consists of a deep layer of photoreceptor cells (*cones* sensitive to form and color, *rods* with greatest sensitivity to light) that synapse with *bipolar cells* (neurons) that synapse with *ganglion cells* (neurons) whose axons form the optic tract (nerve) fibers. Not shown are interneurons and related multiple synapses. The visual stimulus is initiated by light rays interacting with visual purple pigment (*rhodopsin*) in rod cells and the pigment *iodopsin* in cone cells. These interactions induce an electrochemical stimulus that can be conducted through neurons on to the CNS.



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See 157

LAYERS OF RETINA:*

AXON_{M'}

GANGLION CELL_P

BIPOLAR CELL_Q

ROD CELL_R

CONE CELL_S

PIGMENTED EPITHELIUM_T

